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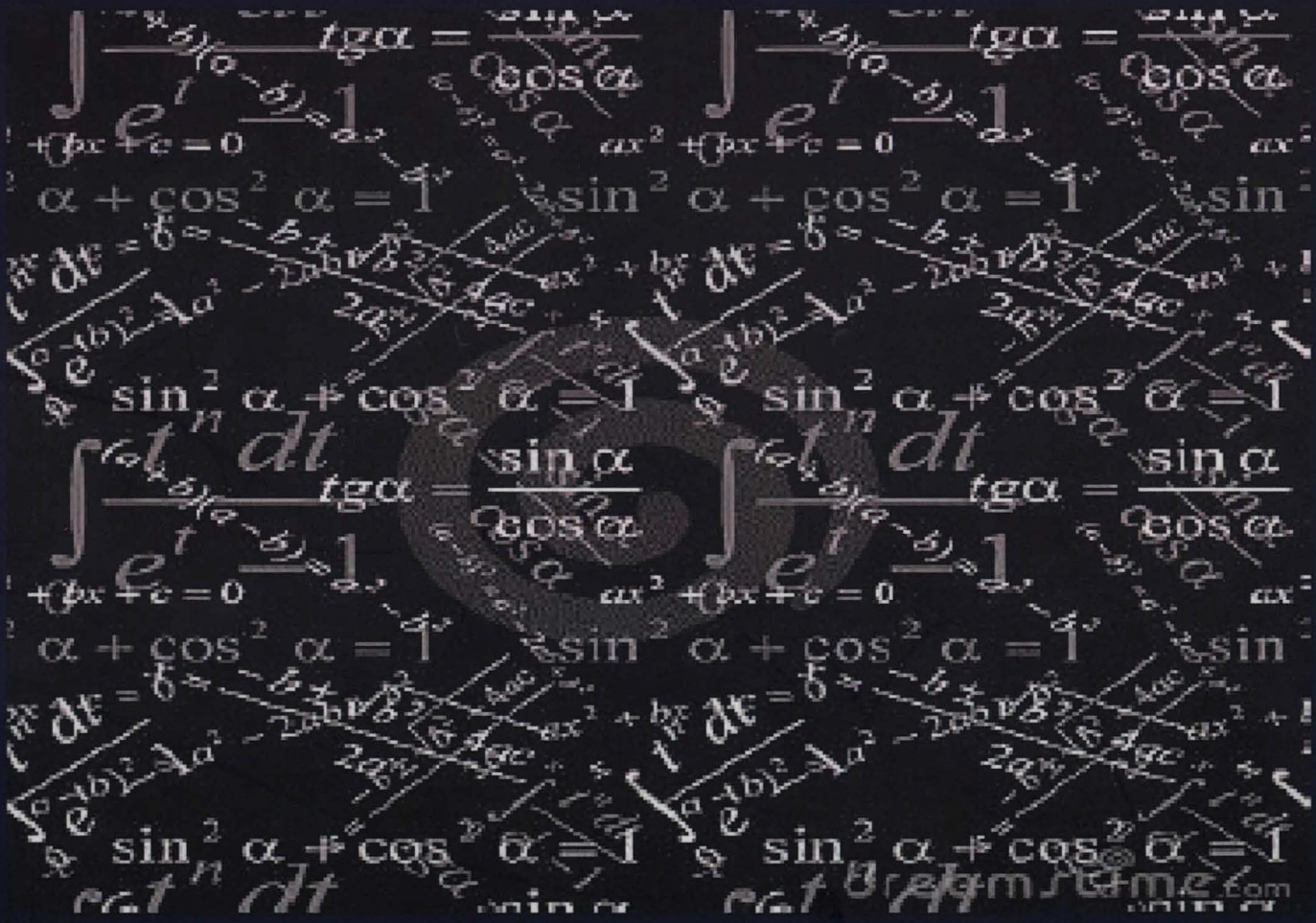

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Part II. Dynamical Systems Arising From Physical Models

CLASSIFICATION OF ξ^s-QUADRATIC STOCHASTIC OPERATORS IN 2D-SIMPLEX

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Abstract

In this paper we introduce a new class of quadratic stochastic operators called ξ^s-QSO. We classify such operators on 2D-simplex, into six non-isomorphic classes, with respect to their conjugacy and renumeration of the coordinates.

Introduction

It is known that there are many systems which are described by nonlinear operators. One of the simplest nonlinear case is quadratic one. Quadratic dynamical systems have been proved to be a rich source of analysis for the investigation of dynamical properties and modeling in different domains. One of such operators is quadratic stochastic operator which naturally arises in modeling of a population dynamics [1]. During many years this theory is developed, and has appeared in lots of papers (see e.g. [3,4,5,8]). In recent years it has again become of interest in connection with numerous applications to many branches of mathematics, biology and physics. One of the central problems of this theory is to study the limiting behavior of trajectories of such operators (see [2,6,7,9]).

Recall that an evolutionary operator of a free population is a (quadratic) mapping of the simplex

$$S^{m-1}=\{\mathbf{x}=(x_1,...,x_m)\in R^m \mid x_i\geq 0, \sum_{i=1}^{m} x_i=1\} \tag{1}$$

into itself of the form

$$V: x_k' = \sum_{i,j=1}^{m} P_{ij,k}x_i x_j, k=1,2,...,m \tag{2}$$

where $P_{ij,k}$ are coefficient of heredity and

$$P_{ij,k}\geq 0, P_{ij,k}=P_{ji,k}, \sum_{k=1}^{m} P_{ij,k}=1, i,j,k=1,2,...,m \tag{3}$$

Note that every element $\mathbf{x}\in S^{m-1}$ is a probability distribution on $E=\{1,...,m\}$. The population evolves starting from an arbitrary initial state $\mathbf{x}\in S^{m-1}$